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# GRC Earth Science Overview

## ESTO TST Quarterly

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# Aerospace Communications



- Objective: Development of revolutionary communication and network systems that significantly increase the capacity and connectivity among satellites, spacecraft, aircraft and ground networks enabling new applications and services. Technologies which improve the power, bandwidth, and cost efficiency of communications at millimeter-wave frequencies and higher, and the interoperability, reliability, security, and quality of services of aerospace networks. Provide this technology to meet the requirements of future robotic and human space missions, National Airspace capacity, safety, and transportation initiatives, NASA's utilization of emerging commercial communications services, and communications technology applications including telemedicine.
  - End- to-end system analyses, modeling, simulation, and demonstrations.
  - Frequency spectrum utilization and signal propagation analyses.
  - Multi-gigabit processing communication payloads; Internet protocols (IP)-compliant aircraft and spacecraft; data distribution networks; satellite constellation networks; and autonomous terminals.
  - Space Internet protocols and technologies for space/terrestrial interoperability.



# Space Communications Program



## Technologies

### Research TRL1-2



RF Materials and Devices

Simulation and Modeling

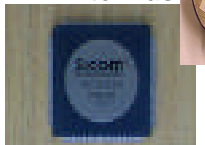
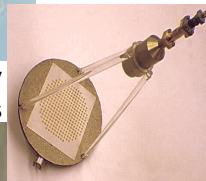


### Technology Products



TRL 2-3 Amplifiers

Array Antennas



Modems and Codecs

### Network Systems TRL 1-3

Architectures and Protocols



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## Expertise & Facilities

### Lab and Facility Testbeds



Aero

### Technology Verification Experiments TRL 4-6



Space

### Services Demonstrations TRL 4-6



## Applications

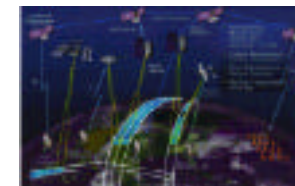
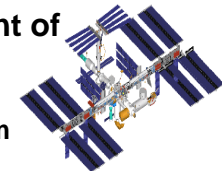


### Space Science

- Cross Enterprise Technology
- High Rate Data Communications

### Human Exploration and Development of Space

- Spectrum Mgmt.
- Advanced Comm
- Space Internet



### Earth Science

- Distributed Information Systems

### AeroSpace

- Aviation Capacity
- Aviation Safety





# Aerospace Power & Electric Propulsion



- Objective: Development of innovative technologies and systems that will result in robust, light weight, ultra highly efficient, lower, cost power and electric propulsion systems that are long-lived in the relevant mission environment to enable future missions. Creative technologies to allow effective generation and utilization of power and significant increases in vehicle payload fraction for future human and robotic spacecraft, aircraft and transportation vehicles. Includes analysis of systems and requirements to provide tactical and strategic guidance for technology advances.
  - End-to-end power and electric propulsion system analysis, modeling and simulation, and mission analysis
  - Production of electricity from any source including solar, thermal, combustion, and nuclear
  - Energy storage including electrical, thermal, chemical, and mechanical
  - Management, control, and distribution of energy
  - Systems to convert electricity to mechanical energy
  - Electric propulsion, including power conversion, controls, vehicle interactions and system integration



# POWER TECHNOLOGY PROGRAM



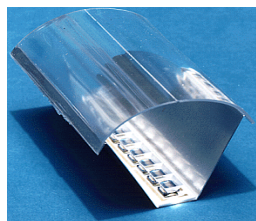
## TECHNOLOGIES

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## EXPERTISE/FACILITIES



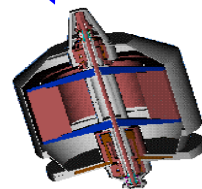
## APPLICATIONS



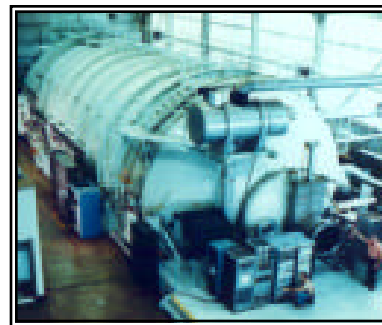
POWER GENERATION



ENERGY STORAGE



POWER MANAGEMENT & DISTRIBUTION



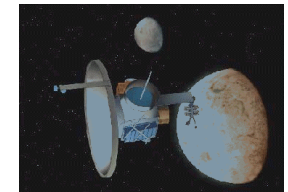
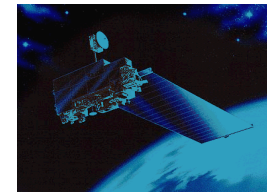
Solar Power Facility

- Highest degree of accuracy solar simulator thermal vacuum chamber



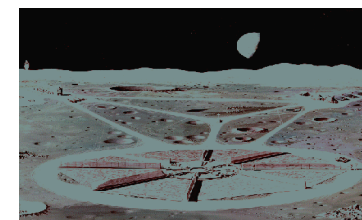
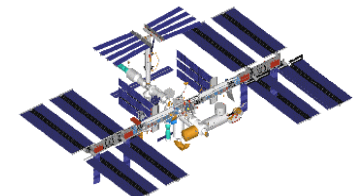
Satellite Power Facility

- Complete source-to-load test bed



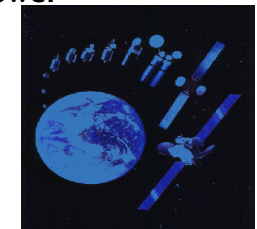
Earth and Space Science Applications

ISS Program Support



Planetary Surface Power Studies

Communications Satellites







# On-Board Propulsion Program



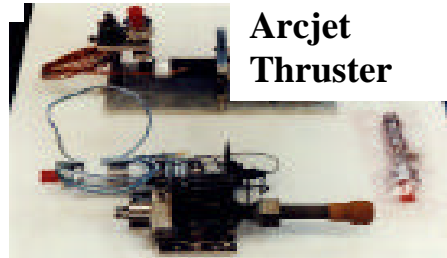
**Ion Thruster**



**Pulsed Plasma Thruster**



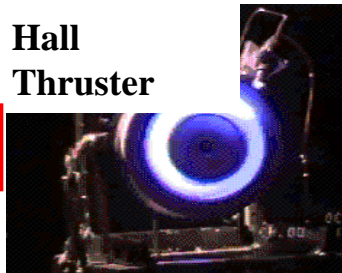
**Arcjet Thruster**



**NASA EO-1 with GRC PPT Engine**



**Hall Thruster**



## Technologies

**Small, High Performance Chemical Rockets**

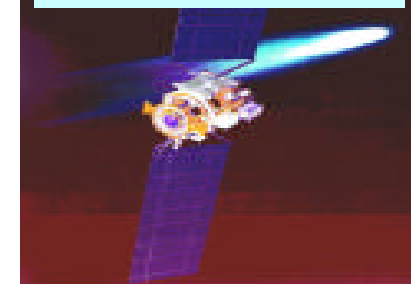


## UNIQUE ON-BOARD PROPULSION DEVELOPMENT AND TEST CAPABILITIES

- WORLD'S HIGHEST FIDELITY SPACE SIMULATION CHAMBERS FOR ELECTRIC PROPULSION
- 13 LARGE FACILITIES, 12 SMALL
- CAPABILITY FROM CONCEPT TO FLIGHT

## Applications

**NASA Deep Space 1 with GRC Ion Engine**





# R2 IP Accommodation Study



- Used the Rapid 2 contracting mechanism to generate a quick, unbiased, outsider's look at the overall impact of implementing IP in Space.
  - 4 vendors (SSTL, Spectrum Astro, Orbital, and TRW).
  - Completely hands off (no firm NASA requirements).
  - Emphasis on COTS technologies and commercial services.
- Expecting 3 study products:
  - WAG impact on existing satellite design (technology / cost, & schedule).
  - At least one end-to-end architecture.
  - Implementation roadmap.



# R2 Outbrief Agenda



## September 20th

0730-0800 Registration  
and Continental  
Breakfast (Provided)  
0800-0845 Introduction  
0900-1200 TRW  
Presentation  
1200-1300 Lunch  
(Provided)  
1300-1600 Orbital  
Sciences Presentation

## September 21st

0800-0900 Continental  
Breakfast (Provided)  
0900-1200 Surrey  
Satellite Technologies  
Presentation  
1200-1300 Lunch  
(Provided)  
1300-1600 Spectrum  
Astro Presentation  
1600-1645 Closing  
Remarks





# Future Space Internet Activities



- JSC / Inspection 2000 (November 1, 2, & 3, 2000)  
Space Internet demonstration over TDRSS and the open Internet.
  - Conceptual ISS/STS network.
    - Router / switches / wireless components / EPCU / experiment.
  - Advanced network security.
  - Desktop command and control via tempest software.
    - USAF / ESTO involvement?
- GSFC / IP-in-Space workshop (November 13-16, 2000).
  - Broad technical agenda.